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ON SOME AMERICAN AND ORIENTAL EARTHWORMS

PART II. FAMILY MEGASCOLECIDAE

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Part I of this article contains descriptions and notes on distributions of earthworms of the families *Moniligastridae*, *Glossoscolecidae* and *Lumbricidae*, sent recently to the Zoology Department of The Ohio State University for identification. Included among this material is the first specimen of the large Indian earthworm, *Drawida grandis* (Bourne) 1886, that has been available for study since the species was first described.

Part II contains descriptions and notes on similar material belonging to the family *Megascolecidae*.

Family MEGASCOLECIDAE

Genus PONTODRILUS E. Perrier, 1874

Pontodrilus bermudensis Beddard 1891

Material examined.—Under sea weed on beach, St. Croix, Virgin Islands, March, 1938, 5 aclitellate specimens. H. A. Beatty per U. S. Nat. Mus.

External characteristics.—Length to 55 mm. Diameter to 2 mm. Prostomium slightly epilobous. Setae: posterior to xx *aa*, *bc* and *cd* are about equal or *bc* may be smaller than *cd*, *ab*<*cd*, *dd*<½C. Nephropores are not certainly recognizable but appear to be on *c*. No dorsal pores.

Spermathecal pores are minute, on 7/8 and 8/9, on or just lateral to *b*. Female pores are on xiv anteromedian to *a* and slightly nearer to 13/14 than the setal arc. Male pores are minute, on xviii, on the setal arc and about on *b*. A grey spot on the setal arc of xviii on *a* appears to mark former site of an aperture into a setal follicle.

Segment xviii is anteroposteriorly elongated ventrally and especially so in a region extending from just median to *a* nearly to *c* on each side. Approximately in *ab* on each side of xviii is a longitudinally placed area of greyish translucence, rather sharply demarcated but with sinuous margins. Each area is indented mesially and laterally by a white, rather conical, undemarcated protuberance, the lateral especially conspicuous, the protuberances reaching highest elevation on the setal arc.

The single genital marking (5) is on 19/20, reaching laterally on each side about half way to *a*, with central translucent and marginal opaque portions demarcated on the larger specimens.

Internal anatomy.—There is a rudimentary gizzard in v (3, not noted in other two specimens). Calciferous glands and lamellae are lacking but the oesophageal wall is thickest and

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most vascularized in xiv–xv. The intestine begins anteriorly in xvii (3), the oesophageal valve in the region of attachment of septum 16/17. No typhlosole.

The dorsal blood vessel (single) is continued anteriorly onto the pharyngeal bulb. A supra-oesophageal trunk is unrecognizable. Extra-oesophageals are large, close to the ventral parietes in i–v, much more dorsal posteriorly, passing onto the gut in xii–xiii, uniting mesially in xiv or xv. No subneural trunk (3). Last hearts in xiii (5).

Nephridia of xiii are small (5), no nephridia in xiv or anteriorly, larger nephridia present from xv posteriorly (5). The preseptal funnels are close to the ventral parietes in *ab*.

Holandric, acinous seminal vesicles present in xi and xii (5). The prostatic duct is curved into a sigmoid or C-shape, one to two mm. long and nearly as long as the gland, with marked muscular sheen. On the median faces of the prostatic ducts within the parietes are very small setal follicles. The vasa deferentia were not traced as they are not certainly recognizable posterior to xi.

The spermathecal duct is about as long as or longer than the ampulla from which it is fairly sharply marked off, adherent (by the posterior face) to or imbedded in the parietes back to the level of the setal arcs of viii and ix. The digitiform diverticulum passes to the median face of the duct within the parietes and is long enough to reach up slightly onto the ampulla.

The epidermis of the genital marking on 19/20 is markedly thickened. White material within the body wall under each protuberance on xviii may be glandular.

Remarks.—The intestine of each specimen is largely filled with coral fragments including some that are as much as 1½ mm. long. Also included is a disc of approximately circular outline and with a diameter of one mm. Bits of coral of appropriate size and disposition in the oesophagus may produce an appearance of the presence of gizzards or of calciferous glands. A bit of yellowish, calcareous tube of approximately segmental length and completely filling the gut in vii produced an appearance practically indistinguishable from that of a gizzard until the gut was opened. The oesophagus in v is widened, the shape approximating to that of a gizzard and the wall is definitely thicker than in iv or vi.

In the spermathecal ampullae of the larger specimens there is brownish material which may indicate that such individuals are in a postsexual stage after completion of clitellar regression.

The worms described above appear to be referable to *P. bermudensis* as now understood but the species is variable and Michaelsen (1909) recognized a number of *formae*, the taxonomic status of some of which must be regarded as doubtful.

Pontodrilus gracilis sp. nov.

Material examined.—Edge of Caloosahatchie River (brackish), Fort Myers, Florida, January 23, 1941, 21 aclitellate specimens. Prof. W. M. Barrows. Caloosahatchie River, Fort Myers, Florida, February 19, 1941, 15 aclitellate specimens. Prof. W. M. Barrows.

External characteristics.—Length to 170 mm. Diameter to 2½ mm. Unpigmented. Prostomium epilobous, *ca.* ½, but with no transverse furrow at posterior end of tongue (20). No dorsal pores. Nephropores are on *b*, presetal, about one quarter of the distance from intersegmental furrows towards the setal arcs, the pores of xviii, often slightly enlarged, just lateral to the genital markings. Setae begin on ii but may be lacking in part on ii–vi, near the hind end the dorsal ranks quite irregular, the lateral setae fairly closely or widely paired or widely separated; on xx, *cd* slightly larger than 2*ab*, *bc*, *cd*, and *aa* about equal, *dd*$>$2*cd*.

Quadrithecal, spermathecal pores minute and superficial, each pore at center of a small, almost circular protuberance, in *ab* and usually on or near mid *ab* (never on *a* or *b*), the intersegmental furrows lacking on the porophores. Female pores are on xiv, median to *a*, about halfway between 13/14 and the setal arc.

Male pores are minute and superficial, on xviii, on or close to sites of *b* setae, the apertures larger than those of setal follicles or of the female ducts but so recognizable only after removal of cuticle, each pore on a small, rounded or conical protuberance which may be surrounded by a marginal band of greyish translucence. On the most mature worms the porophores are

located in the lateralmost portions of a deep, transversely placed depression. Seta *a* of xviii is present on one side or the other of six specimens, on both sides of one specimen, otherwise ventral setae are unrecognizable.

Genital markings are one pair of presetal areas in *ab* on xviii (36). In the less mature specimens the markings are circular, sharply demarcated and each is surrounded by a marginal band of greyish translucence which is continuous with that around the male porophore. On more mature worms markings are elliptical in outline and longitudinally placed, 17/18 unrecognizable ventrally and some slight invasion of xvii possible. On three worms a slightly protuberant genital shield without definite demarcation extends from the setal arc of xvii at least to 18/19 and laterally to *c*. On these specimens as well as several others xviii is elongated ventrally and markedly widened. The genital markings indicate areas of marked parietal modification. Unpaired, median or other genital markings are lacking.

Internal anatomy.—Septa are present from 4/5; 5/6–12/13 muscular, 4/5 slightly muscular, 13/14 strengthened but translucent.

The oesophagus in iv–x is brown and provided internally with low, white, longitudinal ridges; perhaps slightly widened in v but with no gizzard. In xi–xiii the oesophagus is slender and white, widened abruptly just behind 13/14 (36), the portion in xiii with an appearance of an oesophageal valve. From xiv–xviii however the gut is highly vascular, vertical red stripes especially conspicuous on the coelomic surface of the portion in xiv–xvi, the inner wall with numerous, closely crowded, low, longitudinal, white ridges which become less obvious in xvii–xviii. In xviii quite definitely in front of 18/19 (11) or in xix at various distances from 18/19 (10) the gut is again abruptly widened, though not as conspicuously as at 13/14, and the appearance of both inner and outer walls changes slightly. A definite valve in this region is unrecognizable. The inner wall of the intestine is marked off into small squares by slight longitudinal and circular furrows. No typhlosole.

The dorsal blood vessel (single) is continued anteriorly to and under the supra-pharyngeal ganglia. A supra-oesophageal trunk is usually recognizable from xv to 11/12 but is usually empty anteriorly. Extra-oesophageals are first recognizable in v (anterior to 4/5 apparently continued dorsally and then anteriorly into ii), passing onto the ventral surface of the gut only in xiv or xv, united mesially in xv or xvi, usually unrecognizable behind xvii. A rather conspicuous branch passes laterally from each extra-oesophageal in x–xvi on the anterior faces of the septa. The ventral trunk is continued forwards to the anterior margin of the subpharyngeal ganglia where it bifurcates. No subneural. In x–xiii there are large latero-oesophageal hearts, the connectives with the dorsal trunk red and rather conspicuous, the slender, short branches to the supra-oesophageal usually white. The last pair of hearts is in xiii (35), the left heart of xiii lacking in one specimen. There are commissural loops in v–ix, all loops and hearts passing into the ventral trunk.

Nephridia in xiii are small, the funnels club-shaped (23, not noted in other specimens). There are no nephridia anterior to xiii or in xiv (23), the large nephridia always beginning in xv. The tubules are flattened against the body wall, reaching to or nearly to both septa of a segment and dorsally to *d*. The preseptal funnels are close to the ventral parietes in *ab*.

Testes, in x and xi, are rather fan-shaped. Male funnels are free, with smooth, rounded rims. Seminal vesicles in xi and xii are acinous, vertically placed. Prostates are usually confined to the posterior half of xviii, the nephridia in the anterior half. The ducts of the most mature specimens are slightly more than two mm. long, with marked muscular sheen, straight, sinuous, or slightly looped, but never spindle-shaped. The male deferent ducts pass into the ectal ends of the prostates. On the median face of the prostatic duct there is often visible a cord of tissue that looks like a setal follicle. In two worms setae appeared to be present in the follicles but attempts to dissect out the setae were failures.

The spermathecal duct is shorter than the ampulla, narrowed within the parietes, with large lumen. In fifteen specimens the single, digitiform diverticulum on each spermatheca passes into the median face of the duct close to the parietes. In five worms each spermatheca has a lateral diverticulum of the same size as the median and passing into the duct exactly opposite the median junction. A lateral diverticulum of the same size as the median is present in other specimens as follows: on both left spermathecae (2), on both right spermathecae (3),

on the left posterior spermatheca (6), on the right anterior spermatheca (2), on both spermathecae of ix (1), on three spermathecae (1). In the remaining worm the median diverticula are about half the length of the main spermathecal axis while the lateral diverticula (lacking only on the right posterior spermatheca) are much shorter. In one worm with unidiverticulate spermathecae one diverticulum is bifid.

The longitudinal musculature is uninterrupted over sites of the genital markings.

Remarks.—Spermathecae of several worms from each batch, with and without lateral diverticula, have brownish masses in the ental ends of spermathecal ampullae and diverticula, possibly the last remaining evidences of post-sexual regression. The clitellar region shows no evidence of clitellar regression.

The specimens described above are distinguished from *bermudensis* as follows: (1) a slightly more median location of spermathecal pores, (2) presence of symmetrically paired, longitudinally placed, presetal genital markings on xviii, (3) absence of unpaired, intersegmental genital markings in *aa*, (4) junction of diverticulum with spermathecal duct ental to the parietes, (5) tendency to development of a second and lateral diverticulum on the spermathecal duct, and possibly also by (6) a more ventral location of the nephropores as well as (7) the irregularity of setal ranks in a posterior portion of the body. Such a combination of characteristics appears to be sufficient justification for recognition ot a species distinct from *bermudensis* but it is to be remembered that *bermudensis* as now understood is highly variable, comprising a number of *formae* of uncertain status, and that the Florida specimens are aclitellate. Accordingly it is possible that certain characteristics of taxonomic importance may now be unrecognizable on the types of the new species. Nevertheless it appears to be unlikely that with sexual maturity any of the distinguishing characteristics just mentioned will approximate to those of *bermudensis* except for a development of unpaired, intersegmental genital markings-structures which may characterize more than one species of *Pontodrilus*. A satisfactory diagnosis cannot be given until clitellate specimens have been studied.

Genus Pheretima Kinberg, 1867

Pheretima californica Kinberg 1867

Material examined.—New Orleans, Louisiana, August 13–15, 8 clitellate specimens. Southern Biological Supply Co., per U. S. Nat. Mus.

Remarks.—This is the first record of the species from United States since erection on specimens from San Francisco.

Pheretima diffringens (Baird) 1869

Material examined.—Lawn, Fort Myers, Florida, February 19, 1941. 1 clitellate specimen. Prof. W. M. Barrows.

External characteristics.—The first dorsal pore is on (10/11?) 11/12. Genital markings are presetal on vii–ix, midway between intersegmental furrows and setal circles, ca. 2–3 intersetal intervals median to the spermathecal pore lines. Spermathecal porophores are unrecognizable and postsetal markings are lacking.

Internal anatomy.—The intestine begins in xvi just behind 15/16. Hearts of x are lacking, the right heart of ix present. Lymph glands are rudimentary anterior to xxvii but posteriorly are well developed. Unpaired, suboesophageal testis sacs are well above the nerve cord, the ventral blood vessel included. Vasa deferentia of a side come into contact in xii but without uniting at least into xvii. Prostates are lacking but prostatic ducts are fairly well developed, each duct bent into a U-shaped loop. The stalks of the genital marking glands of xviii pass into the parietes just median to the prostatic ducts. The lumen of the spermathecal duct is narrowed in the region of the diverticular junction, slit-like in cross-section entally, more nearly circular ectally.

Remarks.—Seminal chambers of spermathecae are filled with opaque whitish material, testes are large and transversely ellipsoidal but there is no spermatozoal iridescence in seminal chambers, vasa deferentia or on the male funnels.

From information at present available, *diffringens* appears to be the most widely spread of those species imported into this country, directly or indirectly, from China and Japan, having been found from Louisiana to Virginia (no record from South Carolina).

Pheretima hawayana (Rosa) 1891

Material examined.—Greenhouses, Hadley, Massachusetts, January 1941, 3 clitellate specimens. Prof. Esther Carpenter.

Remarks.—The testis sacs are unpaired and suboesophageal, distended by coagluum, the ventral blood vessel on or within the roofs of the sacs, the nerve cord well below the sacs.

Pheretima pingi Stephenson 1925

Material examined.—Kuatun, Fukien Province, China, 3000–5000 feet, July, 1939, 1 clitellate specimen. Min Hsin Li.

External characteristics.—Length 240 mm. Diameter 9 mm. Pigmentation bluish grey, restricted to the dorsum, lacking or scarcely recognizable on transverse, midsegmental bands bearing the setae. First dorsal pore on 12/13. Setal formula: vi/9, vii/8, viii/14, xvii/18, xviii/16, xix/22, 22/ii, 23/iii, 38/viii, 41/xii, 48/xx.

Each spermathecal pore is at the center of a tiny circular, white, opaque area that indents the posterior margin of a transversely placed area of greyish translucence. The translucent areas are on the posterior portions of v–viii, the spermathecal pores about in line with the intersegmental furrows. Prior to removal of the cuticle the pores appeared to be segmental. Each male pore is at the center of a transversely placed porophore of elliptical outline.

Genital markings, aside from those just in front of the spermathecal pores, are on xviii, three pairs. One marking either indents deeply the lateral margin of each male porophore or is actually protuberant from the male porophore close to the lateral margin. Two other markings on each side, somewhat larger but smaller than the male porophores, are just median to the male pore lines, one presetal and one postsetal, the latter in contact with but distinct from the male porophore.

Internal anatomy.—Septum 8/9 is complete but membranous. The first lymph gland is in xvi, on the left side. From xix posteriorly a pair of large glands is present in each segment. Most of the glands have one or more balls of variable size of brownish, granular material within the gland tissues.

The dorsal blood vessel (single) is continued anteriorly underneath the supra-oesophageal ganglia. The supra-oesophageal trunk is unrecognizable posterior to 13/14 and disappears into the dorsal wall of the gut in ix. The ventral trunk bifurcates just behind the subpharyngeal ganglia, the branches passing laterally along with the circumoesophageal nervous commissures. Between the anterior bifurcations and the junctions of the commissures of v, two pairs of vessels join the ventral trunk, possibly commissures of iv and iii or their representatives. The subneural trunk is continued anteriorly a short distance in front of the subpharyngeal ganglia before bifurcating. The extra-oesophageal trunks pass onto the ventral face of the gut in ix and just in front of 13/14 pass off laterally. The left trunk passes into the subneural. All commissures of v–vii and the hearts of ix–xiii pass into the ventral trunk. Commissures of v–vii, a pair of large vessels from the gizzard and the hearts of ix open into the dorsal trunk. Hearts of x–xiii open into the supra-oesophageal. In addition each heart of x–xiii is connected to the dorsal trunk by a white cord, probably a blood vessel, but only those of x are red. A pair of hearts belonging to ix is present but the ventral half of the right heart is quite slender.

Testis sacs of x and xi are unpaired and suboesophageal. The ventral blood vessel is included in the sacs and is almost in contact with floors and roofs both. The nerve cord is well below both sacs. The prostatic duct is 2–3 mm. long.

The spermathecal duct (including the parietal portion) is slightly shorter than the ampulla from which it is sharply demarcated. The lumen of the duct is abruptly narrowed in the region of the diverticular junction. The diverticular stalk is nearly as long as the duct, the ellipsoidal seminal chamber about one quarter the length of the diverticulum. Just in front of each spermathecal duct and sessile on the parietes is a glandular mass. In xviii, on each

side, there are three glandular masses, each mass at least partially imbedded in the parietes so that some dissection is necessary to discover the multiple nature of the glands and relationships to genital markings.

Remarks.—The specimen is in very good condition as is indicated by the preservation of the soft lymph glands. The hearts of ix are clearly behind and independent of the membranous postgizzard septum. The last two pairs of spermathecae are anterior to 8/9. In spite of apparent intersegmental location of the spermathecal pores the completeness of 8/9 presence of hearts in x and the genital markings necessitate identification as *pingi*. The relationships of *diffringens* (Baird) 1869 and *pingi* remain undetermined (*vide* Gates 1938).

Pheretima subtilis sp. nov.

Material examined.—Manured ground in low and damp Shan garden, Meung Nawng village, Salween ferry, Pang Long State, Burma, October, 1 clitellate specimen. H. Young.

External characteristics.—Length 60 mm. Diameter four mm. Unpigmented.

The setae begin on ii, on which segment there is a complete circle, and are small, closely crowded, present ventrally on each clitellar segment: vi/39, xvii/23, xviii/16, xix/24, 42/ii, 69iii, 86/viii, 76/xii, 16/xiv, 18/xv, 20/xvi, 76/xx.

The first dorsal pore appears to be on 11/12. The clitellum is annular, yellowish brown, and extends from 13/14 to 16/17; dorsal pores and intersegmental furrows lacking.

Bithecal, spermathecal pores minute and superficial, on 5/6, widely separated. The female pore is median. Male pores are minute, each pore at or near the center of a small, transversely placed, glistening tubercle with rounded ventral face. The tubercle is slightly depressed and partially covered by a thin, lateral flap. The appearance is such as to suggest that the male pore tubercle is on the median wall of a slight parietal invagination with a thin lateral wall.

The genital markings are unpaired, median, transversely placed, slightly protuberant, intersegmental, on 22/23 and 23/24, extending anteroposteriorly almost to the setae, the midventral setae of xxii and xxiv slightly dislocated anteriorly or posteriorly. The anterior marking is about twelve intersetal intervals wide transversely and is slightly larger than the other marking.

Internal anatomy.—Septa 5/6–7/8 are slightly muscular; 8/9–9/10 lacking; 10/11–11/12 slightly muscular.

The intestine begins in xv. Intestinal caeca are simple, small, with smooth margins. There is a slight rudiment of a glandular collar on the oesophagus just behind the gizzard.

Hearts of x are lacking but a pair of hearts belonging to ix is present. Hearts of xi were not found. All hearts of ix, xii–xiii pass into the ventral blood vessel.

The testis sac of x is unpaired and ventral, the sac of xi unpaired and U-shaped, reaching up to the level of the dorsal face of the gut but not bound mesially to the gut. The seminal vesicles of xi are small, included within the testis sac and imbedded in testicular coagulum. Vesicles of xii are medium-sized. Prostates extend through xvii–xix. The prostatic duct is about 3½ mm. long, rather slender, bent into a U-shaped loop, the ectal limb slightly thickened.

The spermathecal duct is slender and somewhat shorter than the ampulla, gradually narrowed within the parietes, the wall rather thin and with annular ridges internally, the lumen abruptly narrowed in the region of the diverticular junction. The diverticulum which passes into the median face of the duct close to the parietes comprises a stalk and an elongately tubular seminal chamber only slightly longer and thicker than the stalk and with spermatozoal iridescence. Both stalk and seminal chamber are looped, the looping in part approximating to a regularly zigzagged arrangement. Because of the looping the diverticulum just reaches up onto the ectal portion of the ampulla.

Genital marking glands are sessile on the parietes.

Remarks.—Difficulty in characterization of the male externalia is due to softening and slight erosion. *P. subtilis* is distinguished from all other bithecal species with pores on 5/6 by the genital markings.

Diagnosis.—Bithecal, spermathecal pores minute and superficial, on 5/6, widely separated. Male pores minute (and invaginate?), each pore on a small tubercle (within a slight parietal invagination that has a thin wall?). Genital markings unpaired, median, transversely placed, on 22/23 and 23/24. Setae present ventrally on all clitellar segments: vi/39, xvii/23, xviii/16, xix/24, 42/ii, 69/iii, 86/viii, 76/xii, 76/xx. First dorsal pore on 11/12(?). Length 60 mm. Diameter 4 mm. Intestinal caeca simple. Hearts of x lacking. Testis sacs unpaired: of x ventral, of xi U-shaped; seminal vesicles of xi included. Spermathecal diverticulum passing into the median face of duct near parietes, looped, in part in a regularly zigzagged manner, stalk about as long as the slightly thicker, elongately tubular seminal chamber. Genital marking glands sessile.

Genus PLIONOGASTER Michaelsen, 1892

This interesting but inadequately characterized genus has been recorded only from the Philippines (four species) and the Moluccas (Ternate, one species) and is supposed (Stephenson 1930, p. 831) to have evolved from that "polyphletic" complex which must be referred to as *Megascolex* for the present. That complex is restricted to two separate areas, one including Ceylon and South India, the other including Australia (southwestern, southern, eastern and northeastern parts), Tasmania, New Caledonia and Norfolk Island.

Plionogaster sp.

Material examined.—Manila, Philippine Islands, October, three aclitellate specimens in fair condition. Zacharias de Jesus per Prof. R. C. Osburn.

External characteristics.—The largest specimen is 160 mm. long, with a diameter of nearly four mm. The other worms are much less than half as long. Unpigmented (3). The prostomium is rather indistinctly marked off but appears to be proepilobous (3).

Setae begin on ii (3) and are small, rather closely crowded, the setal circles with but slight midventral and mid-dorsal gaps, circles of v-x nearer anterior margins of the segments; xviii/19 (smallest specimen); *ca.* 90/xii, *ca.* 56 near the posterior end, viii/30, xvii/23, xviii/10, xix/18 (largest specimen).

Nephropores are first recognizable with some degree of certainty on x though possibly present also on ix, and are in three fairly regular longitudinal series on each side to xviii; one series about on the male pore lines, another about on the midlateral line, and the third nine to eleven intersetal intervals lateral to the mid-dorsal line. In each series the pores are in the setal circles. Toward the hind end the longitudinal ranks are more irregular, the dorsal rank three or more intersetal intervals lateral to the mid-dorsal line, the ventral rank about the same distances from the midventral line, pores of the lateral rank not always recognizable with certainty. The first dorsal pore is on 12/13 (3, but with a pore-like, possibly functional marking on 11/12 of one of the smaller worms).

Spermathecal pores are small, transversely placed slits on 7/8–8/9 (3). The anterior margin of each pore (largest specimen) is swollen, the tumescence with a transversely elliptical outline, sharply demarcated anteriorly by a short, transversely placed furrow. The single female pore is median, slightly presetal, on xiv, at the center of a small tumescence of transversely elliptical outline (1).

The male pores are slightly postsetal, transversely placed, small, crescentic slits (3). The anterior lip of each pore (largest specimen) is protuberant, the tumescence circular in outline, each pore and tumescence at the center of a small, transversely placed, whitened area of epidermal (?) thickening.

The two genital markings, just recognizable on the largest specimen, are of transversely elliptical outline, unpaired, extending laterally on each side about to the male pore lines, presetal on xx and xviii (but crossing slightly or dislocating anteriorly 17/18?). A central portion of each marking has a greyish translucent appearance. On the smallest specimen there is on each side, on xvii and close to 17/18, about in line with the male porephore, a circular area of greyish translucence, indistinctly demarcated, possibly a rudiment of a genital marking.

Internal anatomy.—All septa from 5/6 posteriorly are present; 5/6–9/10 muscular, 5/6–8/9 especially so.

The gut is rather slender and waite in vi–ix, the portion in viii slightly widened, of spheroidal shape and with thickened cuticular lining (3). In x–xi the gut is more obviously vascularized and in xii–xviii is widened, with walls striated by red, circular bands. A definite valve is present in the anterior portion of xix but is entirely concealed from view by the anterior portion of the intestine which reaches forward into contact with 18/19 (3). The gizzards are three (2) or four (1), separated from each other by long, thin-walled but white intestinal annuli. The length of each gizzard or intervening annulus is much greater than that of a segment and accordingly this portion of the gut is markedly asymmetrical in each specimen. Segmental locations of the gizzards were not determined but the first gizzard appears to be in or shortly behind xxv. A quite rudimentary typhlosolar ridge is present from xix nearly to the first gizzard but does not become recognizable again until 16 or 17 segments behind the last gizzard, finally disappearing from sight in the region of lxii (1) or lxxxv at a point still in the anterior third of the body (1). Caeca and supra-intestinal glands are lacking.

The dorsal blood vessel (single) is continued anteriorly to the region of iii. The ventral blood vessel is unrecognizable anterior to vi. An unpaired supraoesophageal trunk is visible on the gut from ix into xviii. On the ventral face of the gut at the median line from the last gizzard segment into xix or xv is a vessel which is nearly as large as the ventral trunk, bifurcating in xv or xix, the two branches fairly widely separated from each other but adherent to the gut as far forwards as ix, ventrolateral to the gut in viii, unrecognizable from vii anteriorly. No subneural recognizable (3). In the two smaller specimens there are four pairs of large "hearts" in x–xiii, each pair probably communicating with the dorsal as well as the supraoesophageal trunks. In the other worm "hearts" are present in xii–xiii but commissural vessels of x–xi are much slenderer and white. Blood glands and lymph glands apparently are lacking.

Anterior to 5–6 and at each side of the gut there is a large mass of nephridial tubules, each mass falling apart into three sections with a little probing. In vi–ix, on the anterior face of each septum there is a pair of vertically elongated, anteroposteriorly flattened bands of nephridial tubules. From xii–xvii (x–xi?) four longitudinal series of fairly small, closed, parietal micronephridia are present on each side, a slender duct passing laterally from each nephridium to a longitudinally placed vesicle or bladder which is adherent to the parietes (largest specimen). Posteriorly only three ranks of parietal micronephridia are certainly recognizable on each side and bladders were not found. Beginning with xviii, at least, there is in each segment a pair of meganephridia which reach well towards the mid-dorsal line on the parietes just behind the septa. Slightly lateral to the nerve cord on each side and near the ventral parietes is a preseptal funnel. The neck is very slender and has not been traced with certainty to the nephridial tubule. The duct is also very slender and passes onto the posterior face of the septum where it runs dorsally nearly to the margin of the dorsal blood vessel. Passing posteriorly the size of the meganephridia markedly decreases but preseptal funnels are still recognizable almost at the posterior end. On the dorsal face of the gut from a region behind the last gizzard to the hind end and in contact with the lateral face of the wide and flattened dorsal blood vessel there is on each side a translucent tube, the two tubes with occasional transverse connectives. Lacking blood these tubes should be longitudinal excretory ducts and very delicate whitish threads representing the segmental ducts of the meganephridia, in some segments at least, do pass to the excretory tubes.

Testis sacs of x and xi are of the cylindrical type and contain in addition to testes and male funnels the hearts or commissures and the seminal vesicles of xi. The sacs of the largest specimen are filled with coagulum. Seminal vesicles are also present in xii. Prostates are racemose and confined to xviii. The duct is straight, with muscular sheen, thicker ectally, about one mm. long. In the largest specimen a filament, probably the male duct, rises from the parietes median to the duct and passes into the entalmost portion of the duct. The lumen of the duct is slit-like in cross section.

The spermathecal duct (longest specimen) is shorter than the ampulla and nearly as thick. The diverticulum, usually shorter than combined lengths of duct and ampulla, is rather slenderly club-shaped and passes into the duct close to the parietes. The diverticular lumen is large with numerous thin but relatively rather high annular (? or spiral) ridges on the inner wall of the diverticulum. In one of the smaller specimens the spermathecal diverticula are about as long as the main spermathecal axes.

Remarks.—The number of intestinal gizzards, shape of the spermathecal diverticulum, symmetry and location of genital markings and number of longitudinal ranks of micronephridia are the characteristics hitherto used for specific diagnosis and identification in the genus *Plionogaster*. So little material has been available for study that the value of these characteristics is uncertain. Number of gizzards may be variable as in the Moniligastridae. A tubular diverticulum may be distended entally by spermatozoa after copulation so as to be more or less club-shaped. Genital markings may be variable or unrecognizable except at full maturity. The taxonomic value of numbers of micronephridia is unknown and in any case such characteristics must be used with considerable caution in view of the difficulty in recognition of nephropores, the fragility of the nephridia and the occasional fragmentation or even complete disintegration of tubules (perhaps partly as a result of handling during examination of externalia) in specimens that otherwise appear to be very well preserved.

P. horsti (Beddard) 1886 and *P. sivickisi* Stephenson 1933, the two species hitherto recorded from Manila, apparently are distinguished from each other mainly by the genital markings, paired or lacking in *sivickisi*, both paired and unpaired in *horsti*. From those species the present worms may be distinguished by the presence of unpaired genital markings alone. If however there is no intra-specific variation as to number of gizzards, two species are represented in the new material. *P. jagori* Michaelsen 1892, the species supposedly characterized by four intestinal gizzards has paired genital markings only.

Definition of the genus merely as micronephridial (Michaelsen 1900 and Stephenson 1930) is obviously incorrect. In view of the condition of the specimens and the limited material available an accurate diagnosis is still impossible but the following is suggested tentatively: Quadrithecal, spermathecal pores on 7/8–8/9. Female pore median, on xiv. Male pores on xviii. Setae perichaetine. Clitellum annular (?), on xiv–xvi (?, dorsal pores, intersegmental furrows and setae?). Nephropores in setal circles, in three to six (?) longitudinal ranks from ix posteriorly. Unpigmented. All septa from 5/6 present. Gizzards three or four in a region of the intestine from xxv posteriorly, a regressive oesophageal gizzard in viii; intestinal origin in xix, typhlosole rudimentary, interrupted in gizzard region; no calciferous glands. Hearts latero-oesophageal in (x–xi)–xiii; extra-oesophageals pass onto ventral face of gut in ix, unite mid-ventrally in xv–xix, the united trunks continued posteriorly into gizzard region; no subneural. Excretory organs: one pair of open, enteronephric meganephridia with preseptal funnels from xviii posteriorly, opening into paired and fairly widely separated, supraintestinal ducts with transverse connectives; three to six (?) irregularly longitudinal ranks of closed, exonephric parietal micronephridia from ix posteriorly on each side, each nephridium with a longitudinally placed bladder (?); from ix anteriorly nephridia in clusters on anterior faces of septa. Holandric, seminal vesicles in xi and xii. Prostates racemose.

The gizzard in viii and the paired supra-intestinal excretory ducts are similar to conditions in *Pheretima* but the open enteronephric meganephridia are like those of *Lampito*. The supra-intestinal excretory ducts are more widely separated than in *Pheretima*. Intestinal gizzards are known elsewhere only in the Lumbricidae.

Genus DIPLOCARDIA Garman, 1888

Diplocardia is of particular interest because of marked, intrageneric variation in characteristics usually uniform in Megascolecid genera or even through groups of genera of considerable size. The male pores, almost always on xviii in the former subfamily Megascolecinae—as well as in considerable sections of the Acanthodrilinae, Octochaetinae and Ocnerodrilidae, may here be on any segment from xviii to xxi. The primitive condition, location of male pores on xviii, is found only in one species, a Mexican form. Species with male pores on xix are recorded from southern Florida north into Ohio, Indiana, Illinois and Missouri. One species with male pores on xx is known with certainty only from Nebraska with doubtful records (possibly of other species) from Illinois and Ohio. Species with male pores on xxi have been found in Texas and Lower California.

The intestinal origin, so often in xv in the Megascolecidae, may in *Diplocardia* be in any segment from xiv or xv to xix or xx, and apparently without intraspecific variation. In xiv (? but perhaps doubtfully and possibly rather in xx, *vide* Eisen, 1900), in *koebelei* (Mexico); in

xv, in *keyesi* (Lower California); in xvi, in *verrucosa* (Nebraska); in xvii, in *communis* (Illinois), *caroliniana* (North Carolina), *floridana*, *mississippiensis*, singularis (Illinois), *udei* (North Carolina), and two new species (from Texas and Tennessee); in xviii, in *eiseni* (Florida), *longa* (Georgia), *michaelseni* (North Carolina), *riparia* (Illinois), and two new species (from Florida and Tennessee); in xix, in *texensis;* possibly in xx, *koebelei* (Mexico). Assuming that an intestinal origin in xv is primitive and that the greatest departure therefrom is the most highly specialized, the primitive species is Mexican while the most specialized are in Texas and possibly Lower California.

The primitive spermathecal battery presumably comprises four spermathecae and quadrithecal species have been found from Mexico to Nebraska while sexthecal species are now known only from an area including Georgia, North Carolina, Tennessee and Illinois. Species with last hearts in xii are present from Mexico to Nebraska but those with hearts in xiii have been found only in the area from Florida and Texas north through Georgia and Mississippi into Illinois.

Smith (1924) commented on the absence of calciferous glands in species from the north central states and the presence of such glands or high lamellae in forms from the southern states, North Carolina to Florida and Mississippi. New species from a more southern portion of Florida and from Texas, however, have as rudimentary lamellae as any of the more northern forms.

Designation of known species as definitely primitive or highly specialized is impossible, the one with primitive intestinal origin has the greatest degree of specialization in posterior dislocation of male pores, while the species that is primitive with regard to location of male pores may have the most posterior intestinal origin. Species with greatest development of calciferous glands (internal) have male pores on xix only slightly behind the primitive location.

Diplocardia alba sp. nov.

Material examined.—Roadside ditch, Yellow Fern Creek, Fort Myers, Lee County, Florida, January 21, 1941, 12 partially clitellate or clitellate specimens. Prof. W. M. Barrows. Roadside ditch, Fort Myers, Florida, February 19, 1941, 6 small juveniles and 31 partially clitellate or clitellate specimens. Prof. W. M. Barrows.

External characteristics.—Length to 75 mm. Diameter 2 mm. Unpigmented. Prostomium apparently epilobous but with no transverse furrow at posterior edge of tongue. Nephropores are not certainly recognizable but appear to be on *d*. Setae begin on ii on which all four couples are present; on xxiii, $ab<cd<bc<aa$, *dd ca.* $=\frac{1}{2}$C; ventral setae of xviii–xx unrecognizable (16), on viii–ix usually deeply retracted into the parietes and with the tips just visible in the epidermis or invisible, in which case the openings into the setal follicles are clearly visible. The first certainly functional dorsal pore is located on 10/11 (4), 11/12 (11) or 12/13 (1) but one or two rather pore-like markings anteriorly may represent functional pores. The clitellum is light yellow, slightly protuberant when fully developed, annular, extending from 12/13 to 17/18 (16), the clitellar coloration lacking in *aa* on xiii and xvii; sites of intersegmental furrows slightly indicated (more so ventrally), dorsal pores lacking, setae present.

Quadrithecal, spermathecal pores minute, about the same size as apertures of setal follicles, on viii and ix, in *ab*, usually slightly nearer to *b* than *a*, the anteroposterior location variable; slightly behind 7/8 and 8/9 (21); slightly behind 7/8, midway between 8/9 and setal arc of ix (8); slightly behind 7/8, just in front of setal arc of ix (5); midway between 7/8 and setal arc of viii, on or just in front of setal arc of ix (9). Female pores are minute, anteromedian to *a* and slightly nearer to the *a* setae than to each other (16), on an indistinctly demarcated, transversely placed area of epidermal whitening. On one specimen there is a single median female pore.

A male genital shield is not definitely marked off but an area between the setal arcs of xiii and xx may be very slightly protuberant. Seminal grooves are nearly straight, fairly deep—the median margins especially tumescent, in *ab*, between setal arcs of xviii and xx. Prostatic pores (not always recognizable) are at the termini of the seminal grooves. Male pores are minute, each pore on a tiny, knob-like protuberance from the lateral wall of the seminal groove,

the knob about on the setal arc of xix. There are no genital markings but a tiny, circular area around each aperture of the ventral setal follicles of viii and ix is greyish translucent and within a small, circular area of slight tumescence.

Internal anatomy.—All septa are present from 5/6; 7/8–9/10 most opaque but no septa thickly muscular.

Gizzards are in v and vi (16). The gut is slightly widened at 12/13. In xiv–xvi on the inner wall of the gut there are very low, longitudinally placed lamellae which are less obvious in xiii though the outer wall in that segment is as vascularized as in xiv–xvi. The intestine begins in xviii (10), the oesophageal valve anteriorly in the same segment. The typhlosole is represented by a very low, whitish ridge which begins in xviii and is unrecognizable behind lxvi or lxxvi (worm with 131 segments).

The dorsal blood vessel is doubled from xvii through vii (13) or vi (1), the doubled portions widely separated, the trunk simplex in the region of the septa. The trunk may be slightly doubled in xviii and perforate in xix (2) but apparently is never doubled anterior to 5/6. A supra-oesophageal trunk is unrecognizable, the extra-oesophageals recognizable only in v–vi beneath the gizzards and even there empty. Apparently no subneural (10). Vascular loops in x–xiii are larger than anteriorly and with two branches dorsally from each loop, one to the dorsal trunk and the other to the gut but both branches are filamentous and without blood. The last pair of hearts is in xiii (16).

Nephridia begin in ii. Preseptal funnels have been found only in the posterior segments and are close to the ventral parietes in *ab*.

Testes, free in x and xi, are bifid or trifid and flattened. Male funnels are large and with marked iridescence. Coelomic cavities of x and xi are filled with coagulum. Seminal vesicles are in ix and xii (16), the posterior larger. Prostates are in xviii or xviii–xix and xix–xx and are fairly short, not much longer than the ducts, flattened. Prostatic ducts are over two mm. in length, with marked muscular sheen, C-shaped with a short and narrowed ental portion in one or two U-shaped loops. The male deferent ducts of a side come into contact posteriorly in xii and from thence on may be looped, the loops protuberant from the parietes, passing laterally but close to the prostatic ducts of xviii and into the parietes in xix midsegmentally, the ducts united just within or just prior to entrance into the parietes.

The spermathecal duct which is clearly marked off from the rather heart-shaped ampulla is narrowed within the parietes in a rather conical fashion and widened entally from just below the region of the diverticular junction. The lumen is large entally and elliptical in cross section but ectally is narrow. The pendent diverticulum which opens through a slight conical protuberance apparently on the lateral face of the duct (spermathecae usually slightly twisted) near the ampulla by a pore on a small tubercle, vertical ridge or prominence, comprises an ellipsoidal seminal chamber and a very short and slender stalk almost at right angles to the chamber. Occasionally the spermatozoa in the seminal chamber are in one large ventral and one, two or three smaller masses dorsally, slight furrows on the surface of the stalked end of the diverticulum partially marking off small lobes.

Copulatory setae (ventral couples of viii–ix) are curved slightly in a sort of arc, the tip somewhat hastate but with a rather shallow, scoop-shaped depression on the side of arc concavity, ornamentation of 12 to 16 irregularly and widely interrupted circles of closely crowded, fine spines. At the margins of the shafts light transparent spots are visible just ectal to the circles of spines and the margin is incised. Setal follicles are present within the parietes on the median faces of the prostatic ducts but scarcely reach into the coelomic cavities. Attempts to remove the setae failed.

Abnormality.—One specimen lacks the right anterior prostate and duct.

Remarks.—The intestine of one specimen, aside from a brown flecked slime and a few scattered bits of black organic matter, is filled with quartz pebbles.

Of those species of *Diplocardia* with male pores on xix, only *eiseni* (Michaelsen) 1894 and *mississippiensis* Smith 1924 have hearts in xiii and a doubled dorsal blood vessel. *D. alba* is distinguished from *eiseni* by the presetal location of the spermathecal pores and absence of high, lamellar folds in the calciferous section of the gut, and from *mississippiensis* by the absence of calciferous glands, the rudimentary typhlosole and the simple spermathecal diverticulum.

D. eiseni and *D. floridana* Smith 1924 are the only species hitherto reported from Florida. From *floridana*, *alba* is distinguished by the rudimentary typhlosole, the presence of hearts in xiii, the simplex condition of the dorsal trunk in xx–xxv, absence of calciferous glands and the simpler spermathecal diverticulum.

Diagnosis.—Male pores on xix on setal arc, on very small knobs on lateral walls of straight seminal grooves extending in *ab* between setal arcs of xviii and xx. Prostatic pores at termini of seminal grooves and on setal arcs of xviii and xx. Quadrithecal, spermathecal pores on presetal portions of viii and ix in *ab*. Female pores anteromedian to *a*. Setae: $ab<cd<bc<aa$, *dd ca.* = ½ C, ventral setae of viii–ix slightly arced, tip rather hastate but slightly hollowed on concave side of arc, ornamentation of irregularly interrupted circles of very fine spines; (penial setae?). Clitellum annular, 12/13–17/18. First dorsal pore on 10/11–11/12. Unpigmented. Length to 75 mm. Diameter 2 mm.

Gizzards in v–vi; no calciferous glands, longitudinal lamellae in xiv–xvi low; intestine begins in xviii, typhlosole rudimentary. Dorsal blood vessel double in vii–xvii; last hearts in xiii. Spermathecal duct as long as ampulla, a pendent diverticulum with ellipsoidal seminal chamber opening by a very short and slender stalk through a conical protuberance on lateral face of duct into a widened ental portion with large lumen.

Distribution.—Known only from the type locality, Fort Myers, Lee County, Florida.

Diplocardia fusca sp. nov.

Material examined.—Agricultural soil, Fort Worth, Texas, March, 1941, 1 aclitellate specimen. Prof. R. F. Chandler, Jr.

External characteristics.—Length (strongly contracted) 292 mm., the last eight segments uniformly small and possibly regenerate. Diameter 8 mm. There is at least one metameric abnormality in the posterior half of the body. The dorsum of the anteriormost forty mm. is a fairly dark brown, but posteriorly the color rapidly disappears until the dorsum appears to be white though scattered brown flecks are still recognizable for some distance under the binocular, the pigment again recognizable and fairly dense on the dorsum of the last twenty mm. The prostomium is slightly proepilobous. From ii posteriorly there are two deep secondary furrows on each segment. From vi posteriorly a tertiary furrow is present on each of the first and third secondary annuli. Passing posteriorly these tertiary furrows become as deep as the secondary furrows. Nephropores are slightly dorsal to *d*, on the anterior margins of the segments from iii posteriorly. A pair of pit-like depressions on ii probably are nephropores as nephridia are present in ii. Setae are unrecognizable wholly or in part on the anterior segments. On xxiii the formula is approximately as follows: $ab : cd : aa : bc :: 1 : 1 : 4 : 7$, *dd ca.* = ½ C. The first dorsal pore appears to be on 12/13 but there is a pore-like marking on 11/12.

Spermathecal pores are quite small, transversely placed slits on vii and viii *ca.* on *a*, very slightly behind 6/7 and 7/8. Female and male pores are unrecognizable. Prostate pores are transversely slit-like, at the termini of the seminal grooves on the setal arcs of xviii and xx and somewhat median to *b*.

Seminal grooves are slightly concave laterally, reaching to the setal arcs of xviii and xx about at mid *ab* and mesially on xix to *a*. A genital shield is not marked off, a median region between the *a* lines of xix slightly depressed. Setae *a* and *b* of xviii and xx are closely paired and just median to the prostatic pores, the *a* setae slightly displaced laterally, the *b* setae even more displaced mesially. Ventral setae of xviii if present are unrecognizable. Transversely placed, anteroposteriorly short tumescences reaching laterally on each side nearly to *a* on 17/18, 18/19, 19/20 and 20/21, with smooth, glistening, convex surfaces, may be genital markings.

Internal anatomy.—Septum 4/5 is present but delicate, 5/6 strengthened but transparent, 6/7–10/11 thickly muscular, 11/12 muscular and opaque but not as thick as 10/11, 12/13 strengthened but slightly translucent, 13/14 and several succeeding septa strengthened but increasingly transparent.

Gizzards are in v and vi. In vii–ix the inner wall of the oesophagus is marked off into low, longitudinal, white ridges. Midsegmentally in each of segments vii–ix and transversely placed on the dorsal surface of the gut is a small but quite obvious, lobulated ridge of a slightly iri-

descent (glandular?) material. There are no lamellae or calciferous glands but in xi–xiii the inner wall of the oesophagus is provided with numerous, closely crowded, dark red, papillose projections, often pear-shaped or shortly ridge-like. The projections are less marked in x and decrease in size gradually in xiv to mid xv where they end. On the floor of the gut at the median line in xi–xvi there is a fairly high, dark red ridge somewhat like a typhlosole. The inner wall of the gut in the posterior half of xv and in xvi is smooth and with a rather velvety appearance. The oesophageal valve is in the anterior portion of xvii, the intestine beginning abruptly in the posterior half of xvii. The typhlosole begins abruptly in xxii and is of the simple, lamellar type, about two mm. high, the lumen slit-like in cross section and filled with blood. The typhlosole gradually decreases in height posteriorly and is unrecognizable behind cxxiv at a point 138 mm. from the anterior end. Presumably as a result of the strong contraction of the worm the typhlosole is folded in a regularly zigzagged manner. On the floor of the gut in xlviii–lxxxvi, just lateral to the median line on each side, there is a well marked, dark red, longitudinal ridge.

The dorsal blood vessel is doubled in v–xv and anterior to 4/5 remains doubled until it disappears from sight in the pharyngeal bulb. In xvi–xviii the doubled portion is considerably shortened. From xix the dorsal trunk is perforated midsegmentally, the perforations at first large enough to permit passage of a pin but filled with chloragogen. Posteriorly the perforations become smaller and eventually disappear as the trunk loses its broad, flattened appearance and becomes more nearly circular in section. The supra-oesophageal trunk disappears into the gut slightly behind 13/14 and is continued forwards to 9/10. Anterior to that septum the supra-oesophageal appears to be continued as a somewhat irregular, small vessel to 6/7 but is paralleled on one side from 9/10 to 6/7 by a slightly smaller vessel. The extra-oesophageals pass onto the ventral surface of the gut in xi and unite mesially in xiii, passing through 4/5 close to the ventral parietes and then turning upwards to unite just underneath the dorsal trunk so that the vertical portions in front of 4/5 at first look like commissures from the dorsal vessel. Several large vessels from the dorsal face of the pharyngeal bulb pass into the extra-oesophageals and also a large vessel on each side from the ventral parietes. The extra-oesophageals are in communication with each other through short, transverse connectives in vii and ix. The ventral trunk bifurcates just in front of the suboesophageal ganglia, the two branches passing laterodorsally. There is no subneural trunk. Hearts of x–xiii are latero-oesophageal, opening into both dorsal and supra-oesophageal trunks. Smaller loops, in v–ix, open only into the dorsal trunk. All loops and hearts pass into the ventral blood vessel.

Nephridia begin in ii and gradually increase in size posteriorly but in xxiii reach only just beyond *d*. The necks (preseptal) which are long enough to reach half way or more towards the anterior septa are close to the ventral parietes at or just lateral to *b*. The neck terminates entally in a small, dark annulus of the same diameter as the neck so there is practically nothing of a "funnel" shape.

Testes are fairly large, bushy masses free in x and xi. Male funnels are rosette-shaped, those in xi with a very slight iridescence, possibly spermatozoal. Seminal vesicles, in ix and xii, are medium-sized and acinous. The prostates are not confined to single segments. The ducts are three to four mm. long, slender, nearly straight, with slight muscular sheen.

The spermathecal duct is of about the same length as the (probably strongly contracted) ampulla and only slightly narrower. Ectally the lumen is transversely slit-like in cross section but entally is widened and rather star-shaped in cross section due to the presence of several longitudinal ridges that nearly meet in the center. The lateromesially flattened diverticulum is on the anterior face of the duct and connected to the septum next in front by a mesentery. Only the ental half is attached to the duct. In the anterior portion of the diverticulum are several small seminal chambers, each apparently opening into a vertical passage (circular in cross section) located in the portion next to the duct and which opens through a single pore into the duct near the ampulla.

Iridescent material, probably spermatozoal, is present in some of the seminal chambers though this was discovered only on dissection.

Remarks.—Lips of spermathecal and prostatic pores are in apposition, the pores recognizable only after slight traction in the neighboring region has separated the lips. Before this

was observed very definite grey, translucent spots on 6/7 and 7/8 (as well as on 8/9) just in front of the real spermathecal apertures were suspected of being sites of the pores. Inability to remove cuticle from a recently preserved specimen may explain failure to recognize male and female pores.

The clearly visible nephropores enabled confirmation of a prior segmental enumeration, a matter otherwise of some difficulty because of the depth of secondary and tertiary furrows and also because of the absence or invisibility of setae anteriorly.

The vasa deferentia were not traced and no effort was made to remove the penisetal follicles of xviii and xx, or what appeared to be follicles of the ventral setae of xviii, or the ventral setae of vii–ix.

The spermatozoal iridescence in the seminal chambers of the spermathecae would appear to indicate a postsexual condition, but no evidence of clitellar regression was recognized.

D. fusca is perhaps as close to *alba* as to any species now known and is distinguished therefrom by the larger size, the location of the spermathecal pores on vii and viii, the more anterior intestinal origin, the larger typhlosole and characteristics of the spermathecal diverticulum.

One other species, *D. texensis* Smith 1924 has been recorded from Texas (Chillicothe) but is clearly distinguished from *fusca* by location of the prostates and male pores on xx-xxii, absence of hearts of xiii, the simplex condition of the dorsal blood vessel, as well as other important characteristics.

Although a satisfactory diagnosis cannot be given until clitellate specimens have been examined *D. fusca* is clearly distinguished from all other species by its large size and from other quadrithecal species by the location of the spermathecal pores on vii–viii.

Diplocardia gracilis sp. nov.

Material examined.—(Lebanon?), Tennessee, October 6, 1914, 1 clitellate specimen. Prof. H. A. Hill per U. S. Nat. Mus.

External characteristics.—Length 68 mm. Diameter two mm. Pigmentation unrecognizable (alcoholic preservation). The prostomium is proepilobous, the indentation of i slight. Secondary furrows are recognizable only posterior to the clitellum, one presetal and one postsetal on each segment. Nephropores, at least from v posteriorly, are on or slightly dorsal to *d*. Setae begin on ii on which all four couples are present; on xxiv, *ab ca.* = *cd*, *bc* < *aa*, *dd ca.* = ½ C. The first dorsal pore is on 9/10. Clitellar coloration, a faint yellowish, is recognizable with the binocular on xiv–xvii, the epidermis of those segments clearly though but slightly thickened at the mid-dorsal incision as well as midventrally in *aa*.

Quadrithecal, spermathecal pores minute, postsetal on viii and ix, slightly nearer the setal arcs than to the intersegmental furrows, slightly median to *b* except the left posterior pore which is about at mid *ab*. The margin of each aperture is opaque, the pore centrally located in a tiny, slightly depressed, circular area of greyish translucence. Female pores are very slightly median to *a* and about midway between 13/14 and the setal arc.

Seminal grooves are nearly straight, just median to *b*, reaching nearly to the setal arcs of xviii and xx. Male pores are in the seminal grooves slightly behind 18/19 on tiny rounded tumescences. Prostatic pores are just lateral to the termini of the seminal grooves and about on *b*. Just median to the prostatic pores and about at the ends of the seminal grooves are the very closely paired apertures of the penisetal follicles of xviii and xx.

Genital markings are transversely placed areas of brownish translucence in *aa* at the posterior margins of xxi–xxvi (furrows 21/22–22/23 invisible ventrally). On each of these areas there are visible, but only with right direction of light, three, tiny, circular opaque spots.

Internal anatomy.—None of the septa are especially muscular.

Gizzards are in v and vi. The gut is slender in ix–xvii, the inner wall in x–xv provided with low, papillose protuberances in several longitudinal rows, calciferous glands and lamellae lacking. The intestine begins abruptly in mid xviii, the oesophageal valve anteriorly in xviii. The typhlosole which begins in xx is fairly high and thickest ventrally, rather oval in cross section, the lumen—filled with blood—also oval in section.

The dorsal blood vessel is single. Extra-oesophageal trunks are present. No subneural trunk. The last hearts are in xii.

Holandric, the male funnels small and with thick, rounded rims. Seminal vesciles are acinous and in ix and xii. Prostates are restricted to xviii and xx, the ducts *ca.* one mm. long, shorter than the glands, nearly straight, slender, with slight sheen. Male deferent ducts of a side pass in xviii close to the prostatic ducts laterally and then into the parietes just behind 18/19, uniting within the body wall. Two penisetal follicles project conspicuously into the coelomic cavities just median to each prostatic duct but are less than half as long as the prostatic ducts. The main portion of the shaft of a penial seta is nearly straight but an ectal portion is slightly curved the arc of curvature variable, several setae bent at region of curvature. The tips of some are bifid. One seta, apparently the least worn, has a deep incision marking off slightly ental to the tip a large, triangular tooth. The bifid appearance of the other setal tips is then presumably due to erosion of the real tip. Ornamentation sparse, of several circles of fine spines, not always recognizable (worn?).

The spermathecal duct is about as long as the ampulla from which it is clearly marked off, narrowed in the parietes and widened from below the diverticular junction entally. The single diverticulum is lateromesially flattened, the pointed ventral end reaching to the parietes, the dorsal half adherent to the anterior face of the duct, opening into the duct entally but quite definitely below the ampulla.

Ventral setae of viii and ix but not of vii and x are enlarged, without noduli, slightly curved, with simple tips, ornamentation of three or four longitudinal rows of four or five elongated but slender spines. Near each spine there is a longitudinal groove or slit (possibly an artefact).

The body wall is uninterrupted over sites of the genital markings but in section the epidermis (or an outer portion) of the white circles appears to be transparent thus permitting recognition of a small, opaque body, possibly a gland or entral modification of the epidermis.

Remarks.—Spermatozoal iridescence on the male funnels indicates sexual maturity but there is no iridescence in the spermathecal diverticula and the clitellum certainly does not appear to be fully developed. The bending of ectal portions of the penial setae may have been produced in removal of the setae but erosion of tips and ornamentation may be evidence for believing that the worm is in a postsexual stage of clitellar regression.

D. gracilis with four spermathecae, single dorsal blood vessel and last hearts in xii is close to *D. udei* Eisen 1899 from which it is distinguished by the following characteristics: (1) proepilobous prostomium, (2) location of first dorsal pore on 9/10, (3) absence of genital markings in *bc*, (4) presence of genital markings in *aa*, (5) postsetal location of spermathecal pores, (6) presence of a definite, external spermathecal diverticulum, (7) absence of copulatory setae in x, (8) intestinal origin in xviii, and possibly also by differences in the setal formula, shape and ornamentation of copulatory and penial setae.

Diplocardia ornata sp. nov.

Material examined.—(Lebanon?), Tennessee, October 6, 1914, 7 aclitellate and 49 clitellate specimens. Prof. H. A. Hill per U. S. Nat. Mus.

External characteristics.—Length 70–110 mm. Diameter 2–3½ mm. Pigmentation unrecognizable (alcoholic preservation). Prostomium tanylobous (53). On v or vi to xii each segment may have two secondary furrows, one presetal and one postsetal. Posterior to the clitellum secondary furrows are usually unrecognizable. Nephropores from iii posteriorly are on or slightly dorsal to *d*, on ii in line with furrows forming the lateral margins of the tongue of the prostomium or slightly ventral thereto. Setae begin on ii on which all four couples are present; on xxiv, $ab < cd$, $bc < aa$, $dd\ ca. = \frac{1}{2}$ C. The first dorsal pore is on 10/11 (25) but on sixteen of those specimens there is a more or less pore-like marking on 9/10 which may indicate on a few of the specimens presence of a functional pore. The clitellum is reddish brown and, with greatest development, extends from 12/13 to 18/19 but may be lacking or almost unrecognizable on xiii and xviii and even with full development on those segments the clitellar epidermis is much thinner than on xiv-xvii, lacking in *aa* which is always white. Intersegmental furrows more or less definitely indicated, dorsal pores usually lacking, setae present.

Sexthecal, spermathecal pores tiny (slightly larger than the female pores), transversely or diagonally placed slits on the anterior margins of vii–ix just behind the intersegmental furrows, on or just lateral to *a*, each pore on a slightly tumescent, greyish translucent area often mark-

edly protuberant like a small tubercle and reaching to the intersegmental furrow in front. On one worm the right pore of viii is on *b*. Female pores are anteromedian to *a*, closer to each other than to *a* or nearer to *a*, nearer the setal arc than 13/14, on a transversely placed area of marked epidermal thickening that may reach laterally to *a* or *b*, the outline elliptical.

Seminal grooves are in *ab*, usually perhaps nearer to *b*, nearly straight (apparently often distorted by some local contraction) and reaching almost to the setal arcs of xviii and xx. Male pores are in the seminal grooves behind 18/19 and may or may not be on tiny, rounded tubercles which vary in position from just behind 18/19 to level of a presetal secondary furrow. A genital field is not marked off but lateral or median or both margins of the seminal grooves may be more or less markedly tumescent or each groove may be within a longitudinally placed area of tumescence as in certain species of *Dichogaster* or some of the Ocnerodrilids, or tumescence may be recognizable only in nearly circular areas around the termini of the seminal grooves. Prostatic pores are just lateral to the termini of the grooves, about on *b*, the very closely paired apertures of the peni-setal follicles at the termini of the grooves.

Genital markings of 20 specimens are located as follows: 15/16 (4), 16/17 (20), 17/18 (20), 20/21 (4), 21/22 (19), 22/23 (19), 23/24 (18), 24/25 (5). These markings are recognizable and their characteristics determinable only with some difficulty. On the clitellar region with recognizable individual peripheral and central portions (both opaque), paired, closely in *aa* on 15/16, more widely separated on 16/17 (with centers on or close to *a*), still more so on 17/18 (with centers on or near mid *ab*). Posteriorly markings may have much the same appearance as anteriorly and be also widely separated, but more usually all that may be recognized are transversely placed areas of brownish translucence, at first in *bb* but posteriorly contracting into *aa*. On each of these areas, with proper illumination there are recognizable tiny, sharply demarcated, circular areas of opacity, of which there may be four, three or two, or occasionally one—asymmetrical, in transverse rows.

Internal anatomy.—Septa 5/6–6/7 are strengthened but transparent to translucent, 7/8–10/11 muscular but not especially thickened, 5/6–8/9 funnel-shaped.

Gizzards are in v–vi (10) but 6/7 comes into contact mesially with the gut at or just in front of the anterior margin of the posterior gizzard and must be peeled off carefully before the correct location is recognizable. The gut in ix–xvi usually is rather slender. On the floor of the oesophagus in x–xiv is a fairly high longitudinal ridge gorged with blood (10). On the inner walls of the gut in x–xiii there are numerous papillose protuberances (gorged with blood) with a recognizable tendency to arrangement in longitudinal rows but lamellae and calciferous glands are lacking (10). The intestine begins in xvii (10), the oesophageal valve anteriorly in xvii or at the region of attachment of 16/17. The typhlosole begins in xix or xx (10) and is a fairly high (*ca.* one mm.), simple lamella, with lumen vertically slit-like in cross section and filled with blood, gradually decreasing in height posteriorly and unrecognizable behind lxvii–lxx.

The dorsal blood vessel is single (10). A supra-oesophageal trunk is recognizable between 8/9 and 12/13. Extra-oesophageal trunks pass onto the gut in ix and unite mesially in xiii or xiv, anterior to 4/5 with one large branch close to the ventral parietes forwards to i, and smaller branches to the lateral and dorsal faces of the pharyngeal bulb. The ventral trunk bifurcates just anterior to the subpharyngeal ganglia. No subneural trunk (10). Hearts of x–xii are latero-oesophageal but the branch to the dorsal trunk is slender and white. The last pair of hearts is in xii (10). In xiv on each side there is a fairly large, longitudinally placed vessel on the parietes latero-ventrally. In xiii that vessel turns dorsally and eventually passes to the ventral face of the gut and possibly to the extra-oesophageal, a loop occasionally reaching up nearly to the dorsal trunk with something of an appearance of a heart.

Nephridia, behind the clitellum, reach laterally on the parietes about to level of *d*, funnels small, close to the ventral parietes slightly lateral to *b*. Funnels of nephridia of ii have not been found.

Holandric, male funnels rosette-shaped and with brilliant spermatozoal iridescence. Seminal vesicles are in ix and xii, acinous (10). Prostates are relatively large and extend through several segments, as many as ten to twelve. The ducts are slender, with slight sheen, *ca.* two

mm. long, looped entally, slightly longer (*ca.* ½ mm.) than the penisetal follicles. In xviii the male deferent ducts of a side pass just lateral to the prostatic duct, penetrating into the parietes slightly behind 18/19, uniting just within the body wall.

Penial setae are more than one mm. long, variously curved but not S-shaped, the tip slightly flattened on opposite sides, ornamentation of rather widely separated circles of saw-teeth-like appearance. Setae are often bent, wrinkled, with tips broken off, occasionally with slight fibrillation of the ectalmost portion, the ornamentation apparently more or less eroded.

The spermathecal duct is narrowed rather abruptly near the parietes, rather conical within the body wall, sharply marked off from the wider, often rather heart-shaped ampulla. On the anterior face of the duct near the ampulla is a thick-walled, hemispheroidal protuberance which is continued ectally for a short distance within the wall of the duct and finally opening into the duct lumen. Immediately lateral to that chamber is a lateromesially flattened, vertically placed diverticulum with pointed lower end reaching to or nearly to the ventral parietes, adherent to the duct by the upper half and apparently opening into the duct lumen independently. When filled with spermatozoa slight constrictions may mark off two, three, four or five lobes.

The ventral setae of vii-ix are sigmoid but ornamented ectally by short, transversely placed rows of fine spines. These setae are slightly larger than the ventral setae of vi and x which are similarly ornamented.

The longitudinal musculature is uninterrupted over the sites of genital markings which are areas of marked epidermal thickening.

Abnormalities.—One specimen has a spiral metameric abnormality in the clitellar region; right spermathecal pore of viii lacking, clitellum one segment further anteriorly on the right side and two segments further posteriorly on the left side with abrupt demarcation on the three segments exactly at the mid-dorsal line, seminal grooves on two segments only and one segment behind on the left side, right female pore on xiii, right heart of xii lacking, a seminal vesicle in xi—right side, right posterior vesicle rudimentary, right ovary in xii, left posterior prostate lacking, right posterior prostate rudimentary.

In another worm the ampulla of the left anterior spermatheca is completely divided into three lobes, the median and lateral ellipsoidal, smooth-surfaced and distended by hard translucent material, the middle lobe slightly larger and more irregular.

Parasites.—On the cuticle of several specimens there are numerous small, whitish cysts of rather variable size and shape. Each cyst has a thick rind composed mainly of radially placed, needle-shaped crystals apparently of calcium carbonate. Occasionally cysts are closely crowded into plates a millimeter or so in diameter in which definite boundaries of cysts are indistinct or unrecognizable.

Remarks.—Genital markings are no more easily recognized on fully sexual specimens than on the type of *gracilis*.

Gizzards have been located in vi–vii in two species of *Diplocardia* but in one of these the location has been corrected by Stephenson (1933) to v–vi. In the remaining form location in vi–vii may need confirmation, especially in view of the confusion that might be caused by the adherence of funnel-shaped septa to the gizzards.

With six spermathecae, single dorsal blood vessel and last hearts in xii, *D. ornata* is close to *D. singularis* (Ude) 1893 and *D. caroliniana* Eisen 1899 from which it is distinguished as follows: From *singularis* by (1) the tanylobous prostomium, (2) location of first dorsal pore on 10/11 (or even 9/10), (3) location of nephropores on or dorsal to *d*, (4) segmental location of the spermathecal pores, (5) saddle-shape of clitellum, (6) ornamentation of the penial setae, (7) location of genital markings in *aa*, (8) location of genital markings on intersegmental furrows, (9) presence of thick-walled accessory diverticulum on the spermathecal duct, (10) shape of spermathecal diverticulum, and possibly also by differences in setal formula. From *caroliniana* by (1) the tanylobous prostomium, (2) location of first dorsal pore, (3) saddle-shape of clitellum with posterior boundary at 18/19, (4) location of prostatic pores on *b* and slightly more lateral location of the seminal grooves, (5) presence of accessory chamber or diverticulum on spermathecal duct, (6) shape of spermathecal diverticulum, (7) definitely marked off, relatively

wider and shorter spermathecal ampulla, (8) circles of saw-tooth ornamentation on penial setae, and possibly also by a more anterior location of the male pores (vide Eisen, 1900, pl. xiii, fig. 137b). Original descriptions of both species (Eisen, 1899) are unavilable as also the types.

In view of the differences in method of preservation and in manner of description, the possibility of variations in connection with certain characteristics as well as of deformations that may affect recognition of characteristics of penial setae, determination of the taxonomic value of some of the apparent distinctions is at present difficult. Some of the differences listed would not be regarded as of taxonomic value in certain other Megascolecid genera. The distinctions are so numerous and so consistent on all of the material examined that it seems advisable at present to regard the Tennessee forms as specifically distinct from both *singularis* and *caroliniana*. Recharacterization of both species from properly preserved, sexual material from type localities is needed. There is also reason for suspecting that worms from Illinois and Indiana which have been identified as *singularis* differ from the types (or perhaps only from the original description) in ways that are more important than has been recognized (vide Eisen, 1900, and Heimburger, 1914).

Diagnosis.—Male pores slightly behind 18/19, in straight seminal grooves extending in a lateral portion of *ab* between setal arcs of xviii and xx, prostatic pores in *b* and just lateral to termini of seminal grooves. Sexthecal, spermathecal pores slightly behind 6/7–8/9, on or just lateral to *b*. Genital markings on 15/16–17/18, 20/21–24/25, paired or in transverse rows of 4, 3, or 2. Female pores anteromedian to *a*. Setae: $ab < cd$, $bc < aa$, $dd\ ca. = \frac{1}{2}$ C, ventral setae of vii–lx slightly enlarged but ornamented as on vi and x. Clitellum saddle-shaped, 12/13–18/19. First dorsal pore on (9/10) 10/11. Nephropores on or slightly dorsal to *d* but on ii at or just below levels of lateral furrows of the prostomium. Prostomium tanylobous. Pigmentation? Length 70–110 mm. Diameter 2–3½ mm.

Gizzards in v–vi; no calciferous glands or lamellae but papillose protuberances on inner wall of gut in x–xiii arranged in more or less regular longitudinal rows; intestine begins in xvii, typhlosole begins in xix–xx, of simple lamellar type. Dorsal blood vessel single, last hearts in xii. Spermathecal diverticulum lateromesially flattened, vertical, opening into duct entally just lateral to a hemispheroidal, thickwalled protuberance. Penial setae 1 mm. long, tips pointed, slightly flattened on two opposite sides, with a few circles of saw-tooth-like ornamentation.

Distribution.—The type locality is unknown but is somewhere in Tennessee.

REFERENCES

Eisen G. 1900. Researches in American Oligochaeta with especial reference to those of the Pacific coast and adjacent islands. Proc. California Ac. Sci. (3), Zool. 2.

Gates, G. E. 1929a. The earthworm fauna of the United States. Science, 70.

1929b. Earthworms of North America. J. Washington Ac. Sci., 19.

1937a. Notes on some species of *Drawida* and *Pheritima* with descriptions of three new species of *Pheretima*. Bull. Mus. Comp. Zool., Harvard, 80, (7).

1937b. The genus *Pheretima* in North America. Bull. Mus. Comp. Zool., Harvard, 80, (8).

1938. *Pheretima diffringens* (Baird) and other Asiatic *Pheretima*. Lingnan Sci. J., Canton, 17.

1942. Check list and bibliography of North American Earthworms. Am. Mid. Nat., 27, (1).

Hague, F. S. 1923. Studies on *Sparganophilus eiseni* Smith. Trans. Am. Mic. Soc., 42.

Michaelsen, W. 1900. Oligochaeta. In Schulze', Das Tierreich, 10. Berlin.

1909. The Oligochaeta of India, Nepal, Ceylon, Burma and the Andaman Islands. Mem. Indian Mus., Calcutta, 1.

Smith, F. E. 1924. The calciferous glands of *Lumbricidae* and *Diplocardia*. Illinois Biol. Mon., 9.

Stephenson, J. 1923. Oligochaeta. The Fauna of British India, Ceylon and Burma. London.

1930. The Oligochaeta. Oxford.

1933. Oligochaeta from Australia, North Carolina and other parts of the world. Proc. Zool Soc., London, 1932.